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Friar, Jeffery Edward

NAVAL POSTGRADUATE SCHOOL
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THESIS

IMPACT OF LIFE-CYCLE COSTING ON NAVY
FAMILY HOUSING ACQUISITION

by

Jeffery Edward Friar

Decemeber 1986

Thesis Advisor: Roger D. Evered

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In particular, the role of energy costs is examined. A cost benefit analysis demonstrates the merit of life-cycle costing in relation to the 801 program. The inclusion of all life-cycle costs in an 801 program contract should result in a lower total cost to the government. The recommendation, therefore, is that the award of an 801 program contract for Navy family housing should be based on lowest total life-cycle cost.

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Impact of Life-Cycle Costing on Navy Family Housing Acquisition

by

Jeffery Edward Friar
Lieutenant, Civil Engineer Corps,
United States Navy
B.S., Clemson University, 1981

Submitted in partial fulfillment of the requirements for the degree of

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ABSTRACT

The goal of this thesis is to identify ways to improve the selection process for family housing project alternatives. The thesis concentrates on the economic analysis of the current program that allows the government to lease housing from the private sector (i.e. the Section 8Ø1 program).

In particular, the role of energy costs is examined. A cost benefit analysis demonstrates the merit of life-cycle costing for the 8Ø1 program. The inclusion of all life-cycle costs in an 8Ø1 program contract should result in a lower total cost to the government. The recommendation, therefore, is that the award of an 8Ø1 program contract for Navy family housing should be based on lowest total life-cycle cost.

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I. INTRODUCTION

A. CURRENT FAMILY HOUSING PERSPECTIVE

This thesis looks into the financial decision process of the Section 801 family housing program, and investigates the importance of life-cycle costing in the economic analysis.

A literature review established the merit of a life-cycle cost analysis for major programs. Based on the relevance of a life-cycle cost approach, this thesis focuses on the cost analysis of the 801 program.

Before looking at the economic analysis, it is necessary first to provide some history of family housing in the military, the role of the 801 program, and the importance of energy conservation in military family housing. The introduction to the Navy Family Housing Manual provides an excellent insight into the beginnings of military family housing. The following is a quote from that manual.

> The provision of family housing to members of the United States Armed Forces was first authorized in 1782, when an Act was passed which specified that a major general and his family would be provided with one covered four-horse wagon and one two-horse wagon. By the early 1800's it became a general practice to build quarters onstation for the commanding officer and a few of the senior officers and top ranking enlisted men. [Ref. 1]

Through the years, Congress has established many projects to provide housing for servicemen and their families. These projects fall into three categories. The first is military construction fully funded by government dollars. The second involves the use of private capital to construct quarters that are then leased to the residents or the government. The last category involved short-term leases for existing housing to meet a temporary need. [Ref. 1]

Still, a common problem faced by members of the armed services today is the rampant shortage of military family housing. The problem is particularly acute in the younger enlisted families who also have to cope with limited resources.

The root of the shortage lies in both changing demographics of our personnel and the changing roles of the services. In today's world a much higher percentage of service members are married than in the days of more liberal military spending; therefore, the services are placing greater demand on the available supply of housing. Changes in strategy have also contributed to the problem.

The goal of a 600-ship Navy increases the need for new homeports. This increase in demand for housing puts service personnel in direct competition with the civilian market that is already at equilibrium. Also, changing the status of a base

from a training mission to an operational status means a much higher percentage of permanent personnel.

In 1984, the nation became painfully aware of this housing shortage when the 13 year-old son of an army sergeant took his own life. The son's perception was that his family was unable to cope with the imposed economic hardships of living "off-post." [Ref. 2]

Congress remains very keenly aware of the housing shortage. They continuously work on legislation designed to help alleviate the problem. The Sections 801 and 802 programs both deal with governmental leasing in the private sector.

B. THE SECTION 801 PROGRAM PARAMETERS

Public law 98-115 of October 11, 1983 gave the Service Secretariats the ability to lease housing units from the private sector. The 801 family housing program helped to fulfill a need created by the cancellation of the domestic leasing program. The legislation also sought to avoid some of the program violations associated with the domestic leasing program. [Ref. 3]

The program specifies that :

1. The term of the contract cannot exceed a period of 20 years.

2. Service members will forfeit their basic allowance for quarters (BAQ) and variable housing allowance (VHA) when assigned to these units.

3. The program applies only to new homes. The contracting service can require that the homes meet Department of Defense specifications.

4. An economic analysis selects the most cost effective means of providing the required housing units.

The classic lease versus purchase decision best describes the economic analysis required under the 801 program. In simple terms, the program makes a cost comparison between a military construction project to build the needed housing units, and the contractual agreements that provide and maintain the same number of units for a specified period of time.

As in the classic lease versus purchase decision, the chosen alternative has the lowest net present value of associated costs. Under the 801 program, the initial construction cost and the projected annual maintenance costs form the basis of analysis. Omitted from the decision process are the energy costs related to each alternative.

The energy costs were omitted because they were too hard to estimate effectively, and because the topic of energy conservation no longer holds the center stage spotlight. The 801 program analysis assumes that energy costs under each alternative are

equal. Therefore, the government pays the utility bill regardless of the amount.

Appendix A contains an excerpt from Public law 98-115 that established the section 801 program.

C. THE SECTION 802 PROGRAM PARAMETERS

The 802 program provides an alternative means to help alleviate the family housing shortage.

Under an 801 lease the government pays the entire bill, but under an 802 agreement the government only assures the contractor of a predetermined occupancy rate.

The specifics of the 802 program are:

1. The term of the contract cannot exceed 15 years, and cannot be renewed.
2. The program may not apply to existing housing.
3. The rental rates fluctuate with BAQ and VHA rates.
4. An economic analysis selects the best alternative.

The 802 program offers meager incentives to the private developer, and thus it has not proven to be a suitable alternative to other programs.

Appendix B contains section 802 of Public law 98-115.

D. THE ROLE OF ENERGY COSTS IN THE SECTION 801 PROGRAM

To initiate an 801 program application, identified shortage of family housing within a geographic region must occur. Choosing the most cost effective alternative for eliminating the shortage is a three step process. First, the local command develops an engineering estimate for the construction and maintenance of the required number of housing units. The solicitation of request for proposals (RFP's) comes next. In this step contractors submit both initial design concepts and cost estimates for the construction and maintenance of the required number of housing units for the length of the lease. The final step is the decision process. The contracting service evaluates each submittal against established criteria. All approved designs are sent forward to the economic analysis. The economic analysis chooses the most cost effective alternative.

The weaknesses in the 801 program revolve around the economic analysis. The first 801 program economic analysis did not include some cost factors because they were considered to be equal.

A historic investigation in the 801 program reveals that energy consumption costs are ignored because they were presumed to be equal for all alternatives. A cost benefit analysis of alternative

energy devices is used to support the hypothesis that additional savings exist within the 8Ø1 program.

The objective of this thesis is to determine if the inclusion of additional factors, such as life-cycle energy costs, in the economic analysis would improve the decision process for selection of the best alternative. At the same time, this thesis determines if the omission of those factors lead to erroneous decisions.

E. THESIS ORGANIZATION

Chapter I introduces the reader to the section 8Ø1 family housing program, and briefly discusses its role in both the history and current perspective of the whole family housing program.

Chapter II is a historical perspective of Energy conservation in family housing.

Chapter III outlines the current method of economic analysis for the 8Ø1 program. Chapter III also discusses the perceived weakness of the quality point review system.

Chapter IV begins with an examination of the economics of energy conservation and ends with an examination of energy consumption estimation techniques for typical family housing units.

Chapter V presents two examples of life-cycle costs versus initial investment (or construction)

costs. The results of the cost-benefit analysis is presented as the second section of Chapter V.

Chapter VI presents the major conclusion reached in this thesis, which is followed by the recommendation that energy consumption costs be included in the estimate of each alternative's costs. The hypothesis of the recommendation is that if the contracted provider of housing is directly responsible for the payment of the utility bill, then he will have an incentive to provide maintenance that insures the integrity of the energy envelope. The final section of Chapter VI presents topics for further research that were beyond the scope of this thesis.

II. HISTORICAL PERSPECTIVE OF ENERGY CONSERVATION IN FAMILY HOUSING

A. ENERGY OUTLOOK

In the early to mid 1970's, energy consumption was viewed as a weak spot in the national economy. The oil embargo of that era felt like a gun being held to our collective heads. The alarms went off and sirens sounded. Conservation, foreseen as the only savior, had to solve the problem. Alternatives to conservation included burning sulfur rich coal and poisoning the atmosphere with acid rain, or rushing headlong into nuclear power, thus creating radioactive poisons that take a millennium to decay and risk letting the genie out of the bottle. [Ref.4:p.263]

Ten years ago some people predicted the exhaustion of the supply of fossil fuels in 40 years, but today the world is experiencing an oil glut [Ref. 5]. Figure 2.1 expresses an example of recent public opinion.

Figure 2.1 King Features Syndicate Cartoon [Source: Ref. 6]

The cartoon has a double meaning. First, it shows that western society is less dependent on foreign oil than at the height of the oil embargo. Second, the recent drop in prices did not stimulate a corresponding increase in demand. It seems conservation solved most of the short run problems, so once again the public attitude toward energy consumption is very apathetic.

The Soviet nuclear disaster at Chernobyl and this country's problems at Three-Mile Island serve as reminders that nuclear fission still has many problems beyond the current technology [Ref. 7]. Other alternatives such as active solar, geothermal, and ocean tidal energy are too limited in their areas of application, and they are often too costly for the benefits they provide.

B. ENERGY USE IN HISTORY

How did the potential saving from conservation become so great? Dumas calls the widespread wastage of energy "a result of conscious or unconscious social choice and not [a result of] technical or economic necessity" [Ref.4:p.17]. In the name of progress, have the lessons learned by our ancestors been forsaken? Consider the Eskimo's igloo; its construction is perfect for its environment. The dome shape not only concentrates the heat in the

center of the structure, but the dome itself offers the lowest possible ratio of exposed surface area, (i.e. subject to the environment,) to enclosed volume. The building material is also very important; dry snow absorbs very little heat, meaning that any heat source inside the igloo does not have to first fill up the heat reservoir of a high thermal mass wall [Ref.4:p.26].

In a hot climate a high thermal mass wall is very useful. Indians of the American Southwest built pueblo structures that were the apex for natural control of seasonal climatic impacts, given the available adobe construction technology [Ref.8:p.3].

Watson cites the changes in technology associated with heating equipment as another principle cause of energy waste [Ref.8:p.8]. Thus, as industry learned to provide cleaner sources of heat, the source was moved further away from where it was needed. Our ancestors conserved energy, not because of costs, but because nature is extremely unforgiving. The efficiencies gained by technology were lost to the advances of architectural preference of modern man.

Some conservation measures are passive in nature and require little or no extra cost in addition to a non-energy conscious design. Figure 2.2 contains an example of proper solar and prevailing wind alignment

for a group of houses. In Figure 2.3 the effect of an orientation change and the elimination of some windows can be seen graphically.

Overall, conservation measures do have positive costs, and those costs are inversely correlated to consumption costs. Advances in energy technology are slowly being made, but the alternatives to conservation remain very expensive.

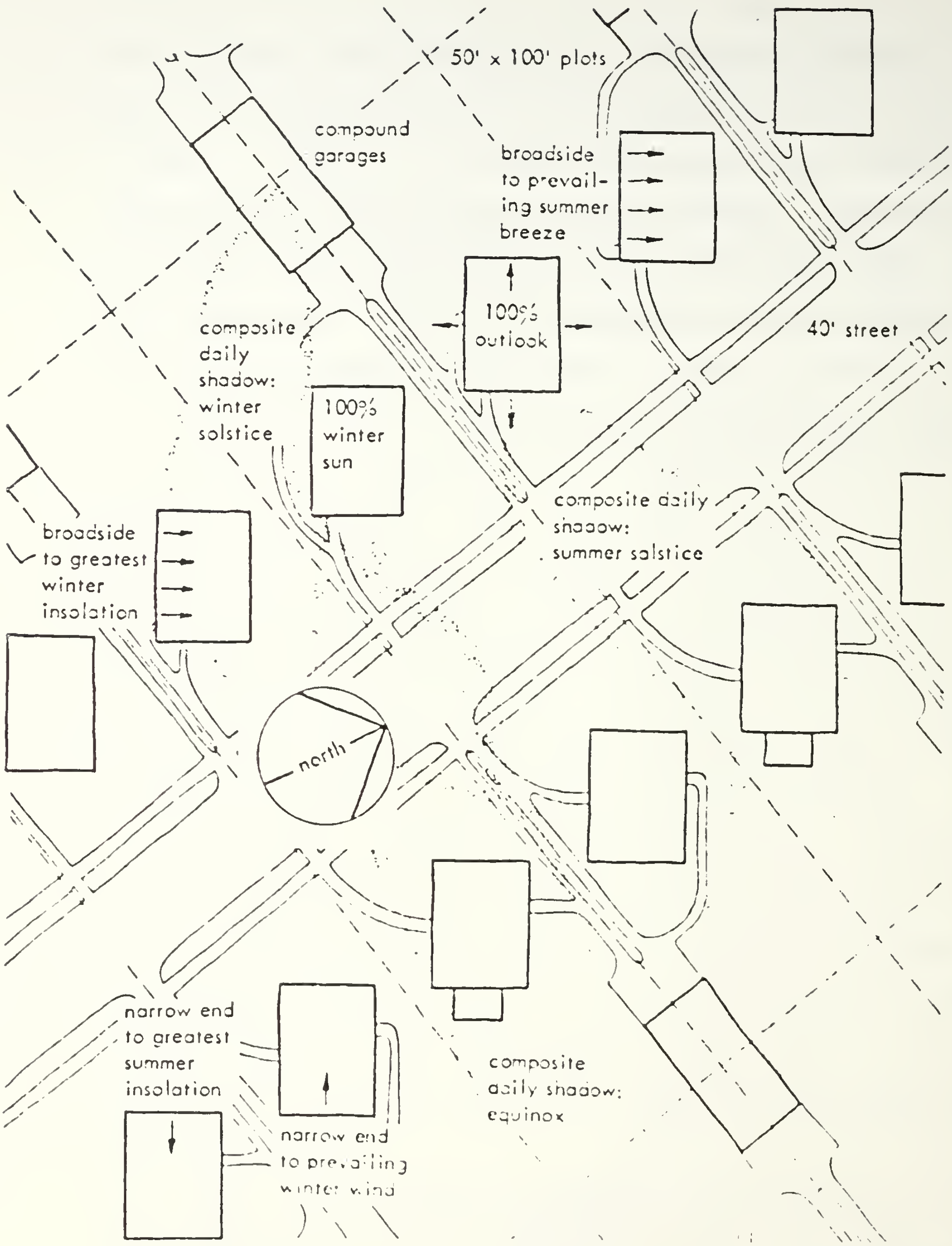


Figure 2.2 Proper Solar Alignment
For a Housing Development
[Source: Ref. 9:p.40]

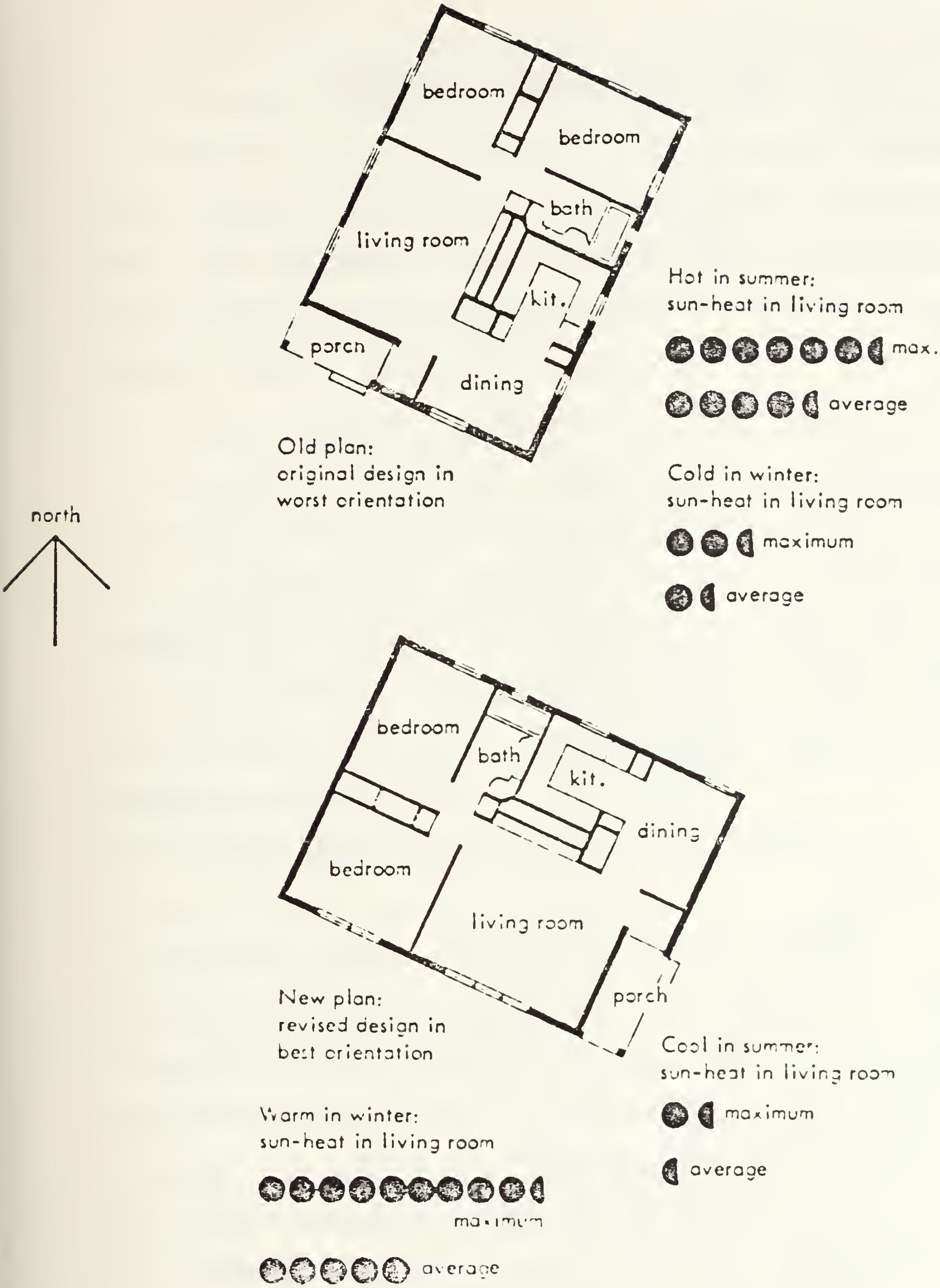


Figure 2.3 Comparison of effects of solar radiation on a house in the New York area, in two perpendicular orientations. [Source: Ref. 9: p.39]

III. THE 801 ECONOMIC ANALYSIS

A. GENERAL

As stated in Chapter I, this thesis deals with the weaknesses of the economic analysis. The weaknesses result from the omission of certain cost factors from the decision criteria. The energy utilization costs are the specific concern.

Restating a point made earlier, the first economic analysis omitted the energy costs because they were too hard to estimate effectively, and because the topic of energy conservation no longer holds the center stage spotlight. Preliminary 801 program estimates assumed the energy costs under each alternative to be equal. So, under an 801 contract the government pays the total utility bill regardless of the amount.

Most elected federal officials' major concern is reducing the deficit. Potential energy related savings may lie hidden in the 801 program. Today it is more important to look at potential dollar savings than to look at savings in terms of BTUs.

It is not known in the beginning how much of total life-cycle cost pie will be attributed to energy consumption. It is not even known at the beginning the size of life-cycle pie with 100%

accuracy. If the initial construction costs are increased, the expenditures for energy and maintenance can be reduced. Increasing the level of maintenance on items such as weather stripping or heating equipment can also reduce energy costs. Figure 3.1 shows three possible scenarios involving energy costs. [Ref. 10]

B. THE ECONOMIC ANALYSIS

Once a housing unit shortage has been identified, the local command examines the various means of providing the required number of housing units. This preliminary review decides the correct avenue of approach. For this thesis it is assumed that the choice is between and 801 lease and a military construction project.

This comparison is best described as a classic lease versus purchase decision. In order for this type of comparison to be valid, the lease must be an operating lease as defined by Financial Accounting Standards Board (FASB) Statement No. 13. [Ref. 11] FASB Statement No. 13 outlines the relationship between lease and leasor. The lease versus purchase decision is based on the lowest present value of the differential cash outflows for each financing alternative scheduled and discounted to the present, if all other considerations are equal. [Ref. 12]

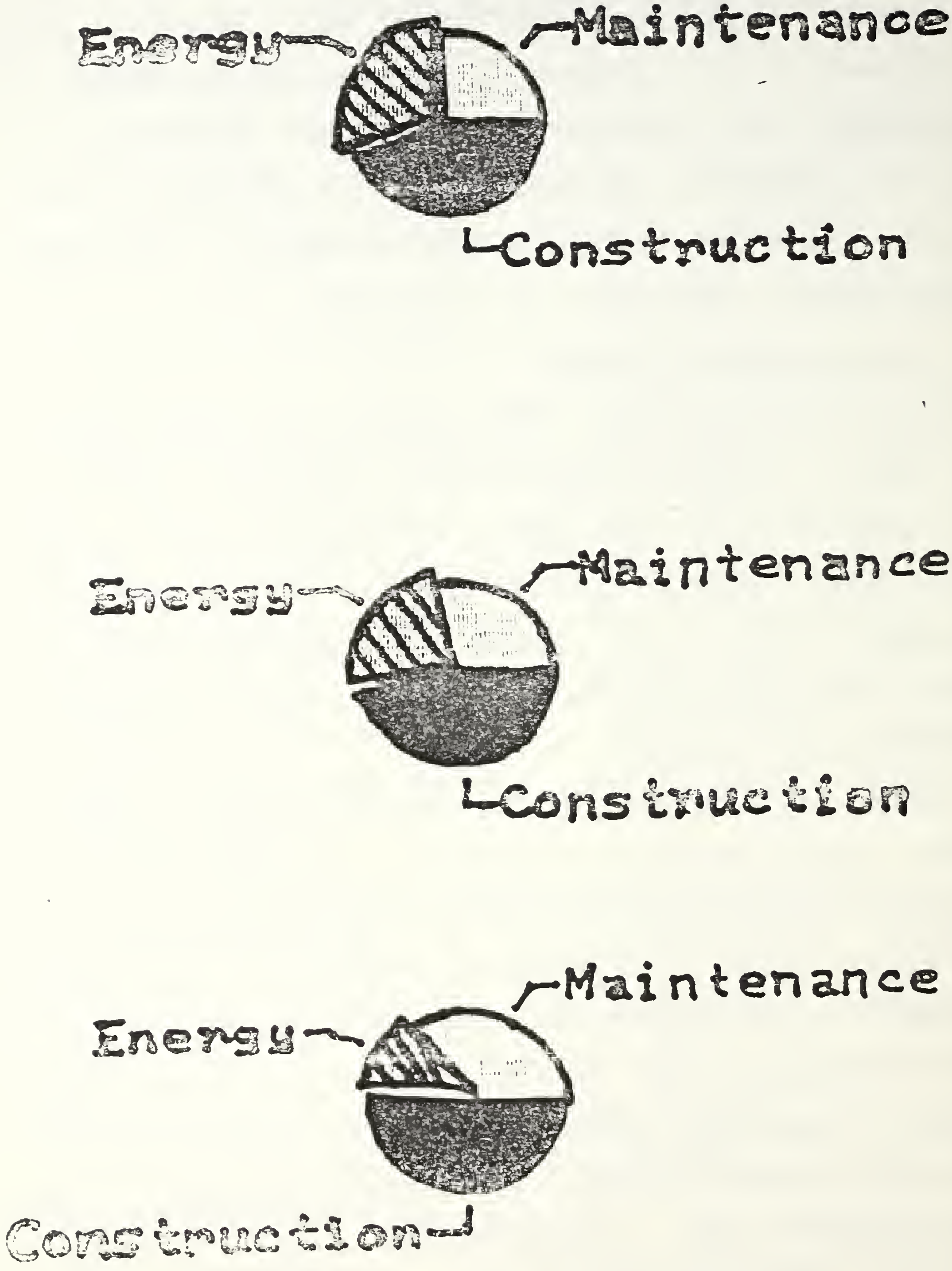


Figure 3.1 Approximate Cost Relationships Between Energy, Maintenance and Construction [Source: Ref. 10]

The development of the Life Cycle-Net Present Value (LC-NPV) is relatively easy and objective. The LC-NPV is the discounted summation of all costs associated with an alternative for the life of the contract. To remove some of the subjectivity associated with making all other considerations equal, a point system evaluates the contractor proposals objectively.

A rough outline of the quality point system is:

--Site Design	300
--Site Engineering	100
--Dwelling Unit Design	500
--Dwelling Unit Engineering and Specifications	100
--Maintenance, Repair, and Operational Services	200
--Total Maximum Points	1200

Appendix C contains the quality point system in detail.

This system evaluates each alternate proposal on its own merit; in other words, it makes all considerations besides LC-NPV equal. The 500 points set aside for dwelling unit design contains 100 points for energy conservation, which are not enough to insure the most energy efficient design. The previous chapter explained that modern man has a predilection for inefficient energy designs. Evaluating this preference in light of the quality point system, a radical energy conservative design could lose more points for bad aesthetics than it

could gain for energy efficiency. The technical parameters only assure that the contractor will meet a predefined minimum. If he reduces the life-cycle costs of energy required for heating by 50 percent, he receives 50 quality points. It does not seem very probable that his cost will be more than 4.35% higher than the alternative of only meeting the minimum standard, (i.e. 1150 points).

The LC-NPV for the military construction project follows the guidelines of the Office of Management and Budget (OMB) Circular number A-104. Circular A-104 outlines the factors governing the lease versus purchase decision for all government agencies. For the lease, the only factor is lease payments, and for the 801 program, lease payments are a combination of shelter rent (SR) and maintenance rent (MR). The factors under consideration for the purchase alternative are:

- construction costs, including fair market value of the land;
- operation and maintenance costs;
- imputed property taxes;
- imputed insurance premiums; and
- cost offset: terminal value at end of the lease period.

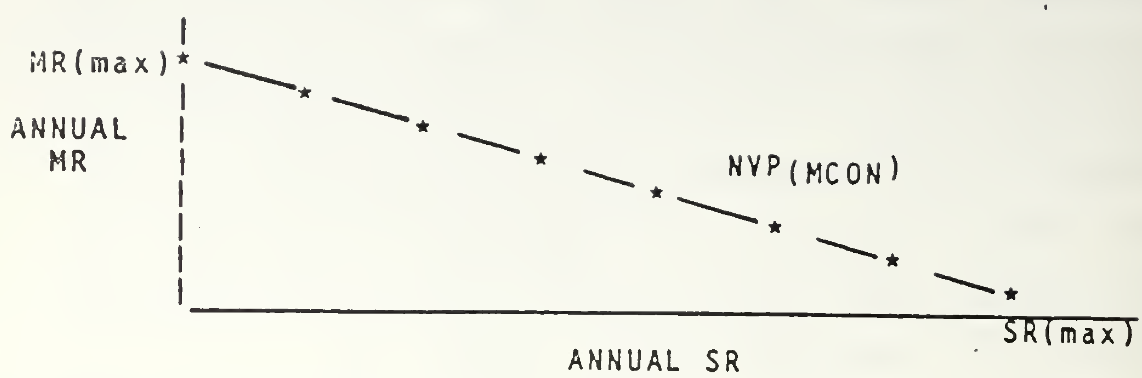
After all outside proposals have undergone the quality point evaluation, a separate review

committee opens the sealed cost portions of the proposals and uses them to determine the LC-NPV of each alternative. The discount factor used for the present value analysis equals the prevailing interest rate on new issues of U.S. Treasury securities with maturities equal to the term of the lease, plus one-eighth of a percentage point. [Ref. 13]

Next, dividing each alternative's LC-NPV by its quality points provides a decision criteria based on the least cost per quality point. Some basic parameters ensure that the final review does not consider alternatives that are infeasible.

The costs of the military construction project establish the cost horizon curve, and the cost horizon defines the limitations of consideration. Figure 3.2 shows a sample cost horizon curve. Any proposal inside the cost horizon curve is acceptable. The program selects the alternative with the lowest costs.

The guidance of the circular does permit the exclusion of those factors that are deemed to be equal. Energy costs were originally assumed to be equal for each alternative. In the next chapter, energy estimation techniques are reviewed and the potential cost savings are evaluated.



MAXIMUM AVERAGE ANNUAL RENT = MAXIMUM VALUE OF SR AND/OR MR

NPV_{MCON}=SR(6.851)+(10.594)

For SR = 0
MR = 28.162/10.594 = <u>$2.658M</u>

For MR = 0
SR = 28.162/6.851 = <u>$4.111M</u>

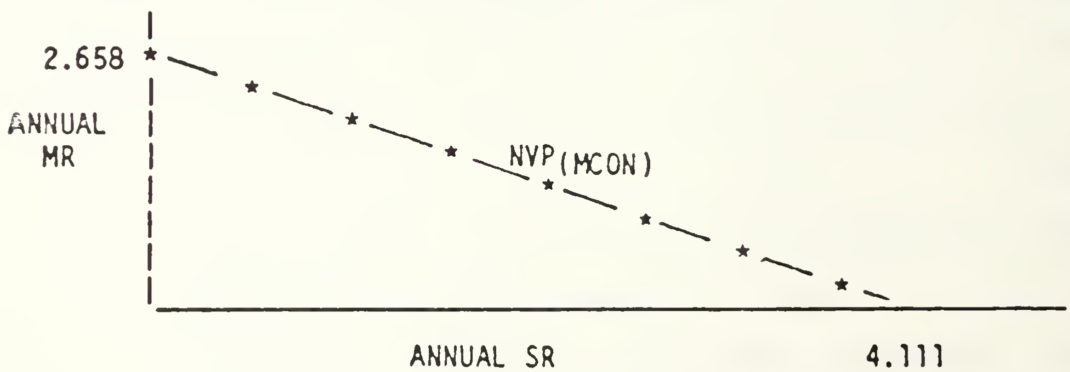


Figure 3.2 Sample cost horizon curve for the Military construction alternative under the Section 801 family housing program. [Source: Ref. 14]

IV. ENERGY FACTORS

A. THE ECONOMICS OF ENERGY CONSERVATION

Today's Congressional emphasis is the reduction of the federal deficit. The bottom line is that spending today must be limited to ensure the ability to spend in the future. This particular mindset places an extraordinarily heavy emphasis on the first cost of any construction project. The problem is that a penny saved today may be a dime wasted in the future. A life cycle cost analysis must be done to determine whether the penny or the dime is more important, because the timing of events and the discount factor determine their value today.

The apathy expressed toward energy conservation ran rampant in the days of unlimited fuel supplies before the oil embargo. Prices for fuel declined, and identified reserves and demand increased. From 1950 until 1973, the average price of energy (adjusted for inflation) per million BTUs rose only 14.3 percent. Between 1959 and 1970, the price of energy actually decreased by more than 8 percent. [Ref. 15] The supply and demand curves for energy are unstable over time. They are both moving, but not at the same rate. If the supply increases faster than the demand, the excess supply pushes prices

downward; but if demand outpaces supply, then an upward pressure is exerted on prices.

If it is assumed that energy prices remain constant the interaction between conservation and consumption costs can be looked at. Consumption costs and conservation costs are inversely related; therefore, as more resources are applied to conservation, consumption requires less resources. The cost curves associated with consumption and conservation add together to provide a total cost curve. Figure 4.1 contains all three curves. [Ref. 16]

The lowest point on the combined cost curve, point Q_C, indicates the minimum obtainable cost. The minimum cost indicates the target level of conservation. Estimating energy consumption reduction resulting from a single conservation measure is relatively straightforward, but when more devices or measures interact together, assessing their individual benefits becomes very difficult. Figure 4.2 shows the relationship between conservation costs and energy saving. The energy savings are derived by subtracting the consumption cost curve from a constant cost equal to the initial consumption cost with zero conservation of Figure 4.1. Adding the energy savings curve of Figure 4.2 to the consumption cost curve of Figure 4.1,

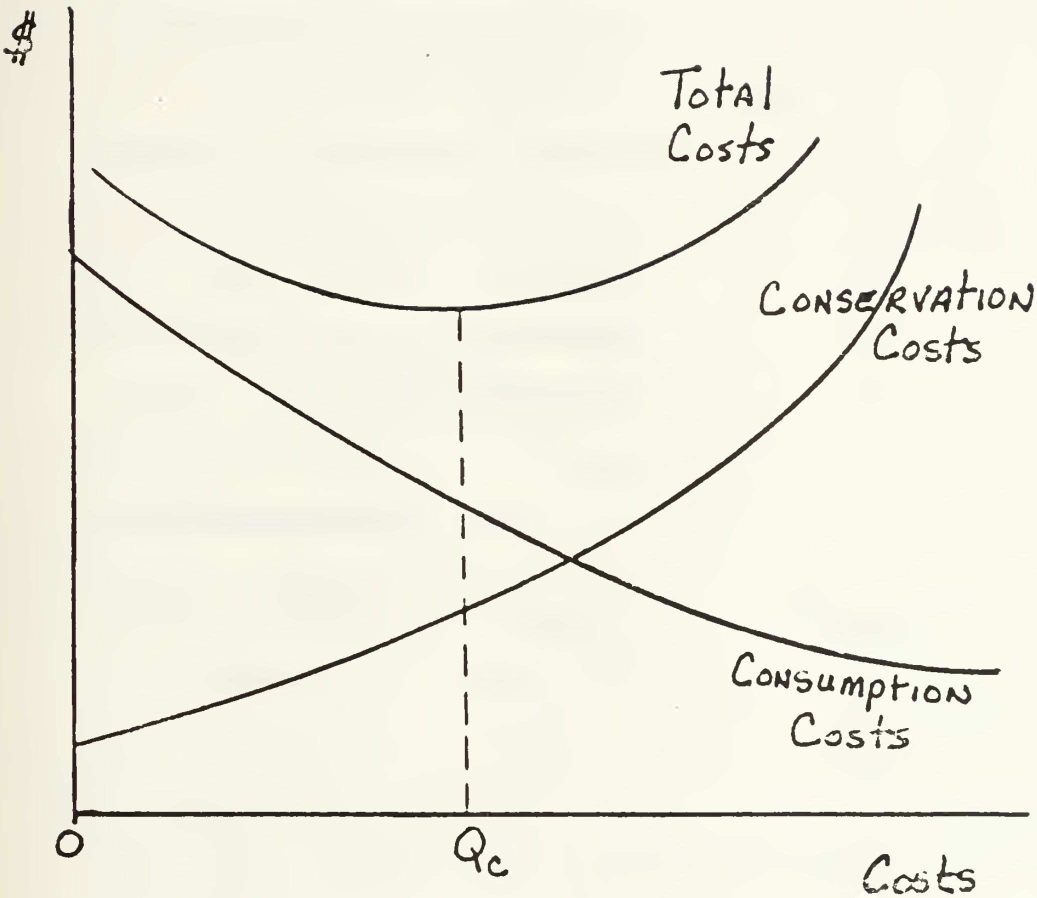


Figure 4.1 Conservation Cost Versus Consumption Cost [Source: Ref. 16]

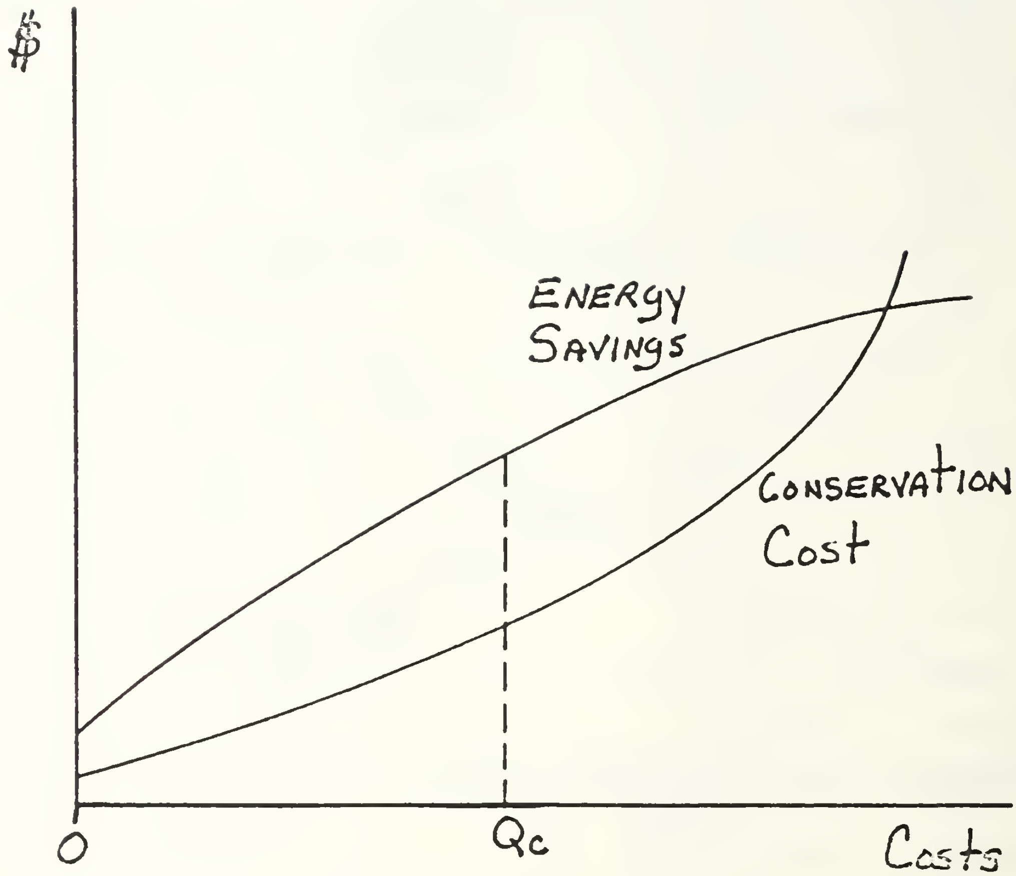


Figure 4.2 Conservation Cost Versus Energy Savings [Source: Ref. 16]

therefore, produces a constant cost line. Point Q_c corresponds to the same level of conservation in both Figure 4.1 and Figure 4.2.

A marginal benefits analysis of individual conservation measures is much easier to calculate. Starting with a baseline level of consumption, we can conservation projects can be avaluated based on their savings subtracted from the baseline, until the decreasing marginal benefits curve crosses the increasing marginal costs curve. The intersection of these two curves indicates the ideal level of conservation. Figure 4.3 shows this relationship.

These economic relationships prove that energy conservation projects are beneficial as long as they save more than they cost.

B. ENERGY CONSUMPTION ESTIMATION TECHNIQUES

It should be apparent that investment in an energy conservation project that has an initial cost higher than the present value of the future inflow of savings is unwise. The initial cost of an energy conservation project is easily obtainable, but the approximation of timing and size of the savings stream is more elusive.

Most methods for energy consumption estimation revolve around the building envelope concept. Under the building envelope concept, the differences

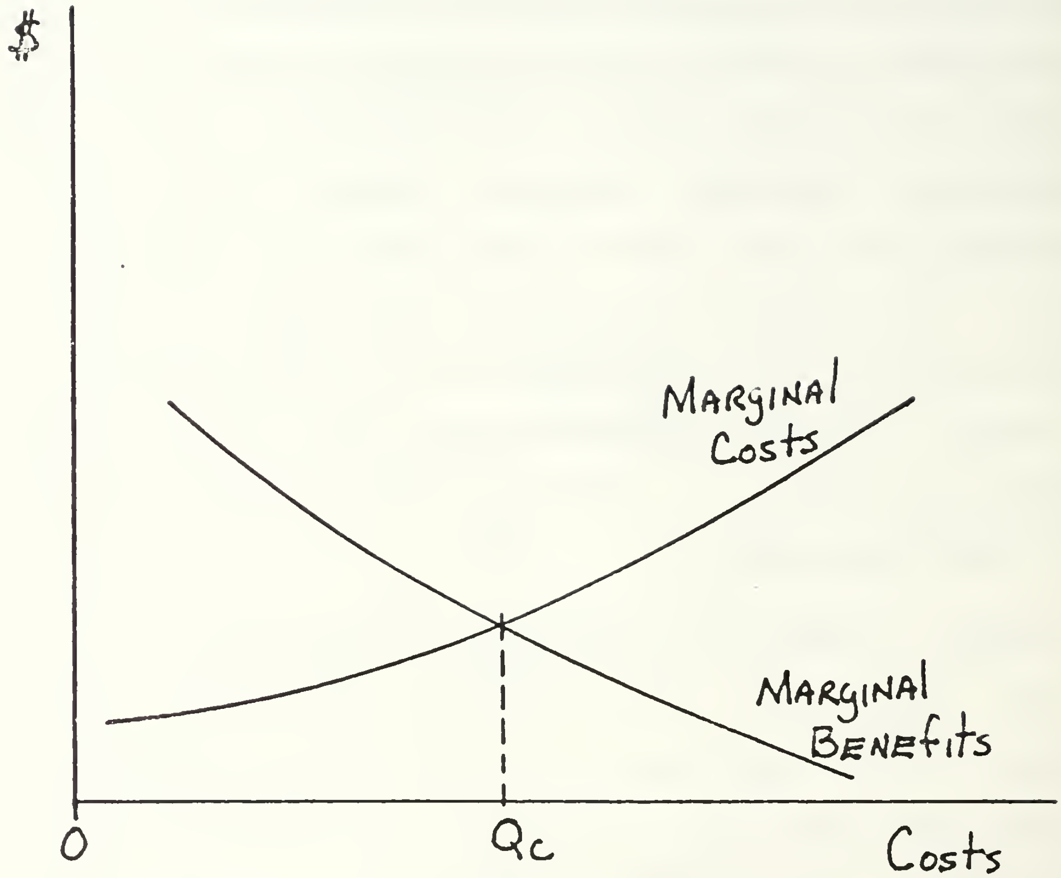


Figure 4.3 Marginal Benefits Versus Marginal Costs Of Conservation
[Source: Ref. 16]

between interval and external environments determine how much energy the house requires. The only mediating force between the internal and external environments is the building envelope (i.e. the exterior walls, the floor and the roof). Examination of a typical cross-section of various exterior windows show relatively how much energy each window transmits, either from interior to exterior or from exterior to interior. (See Figure 4.4.)

Different wall types could be compared to determine the energy efficiency and the standard cost for each wall. To determine the energy efficiency of a wall, a technical evaluation of the thermal conductivity of the wall must be performed.

Energy conservation projects involving mechanical equipment are easier to estimate, because most mechanical equipment is pre-rated for energy efficiency. Thus, when a heat pump is compared to a conventional gas furnace, the required output is known and it is a simple calculation to determine the required input energy needed. The difference between the energy consumption of the alternatives reflect the savings potential. The potential savings must then be evaluated with respect to the cost differential between the alternatives.

A much easier approach is available to all federal agencies, which is a computer program

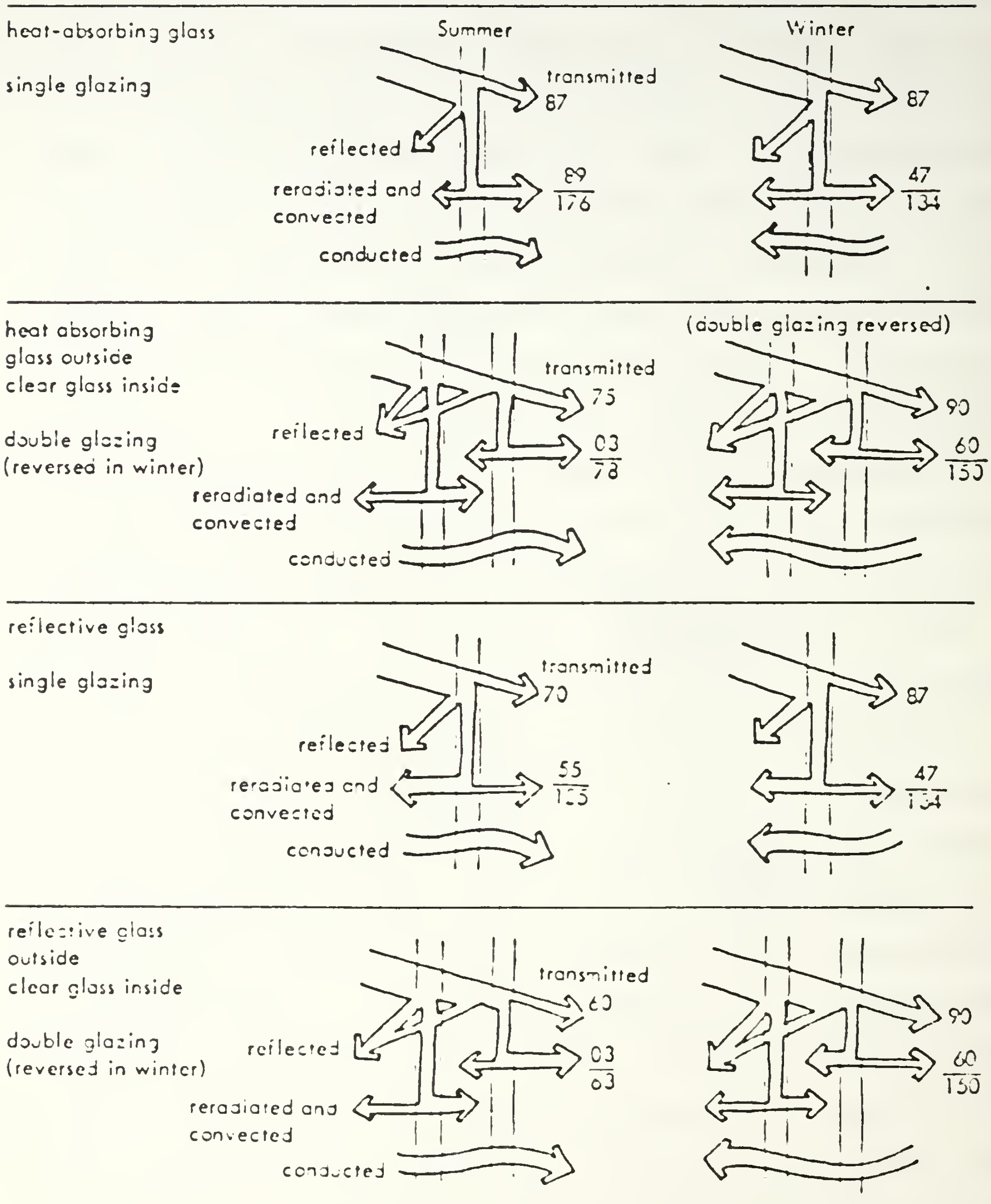


Figure 4.4 Effects Of Solar Irradiation On Various Window Types [Source: Ref. 9: p.43]

developed by the Department of Energy called "COSTSAFR" [Ref. 17]. Activities can use "COSTSAFR" to generate an analysis of an array of housing alternatives. The program compares proposed housing designs to an established standard design. The goal is to minimize the overall costs, including first cost and future utility costs though an energy conservative design. The common thread to all energy consumption estimation techniques is the performance of a net present value analysis.

V. LIFE-CYCLE COST ANALYSIS

A. EXAMPLES OF LIFE-CYCLE COST ANALYSIS

As previously stated, most major system acquisition strategies rely heavily on life-cycle cost analysis. This approach places as much emphasis on operational costs as it does on production or construction costs. To access the potential value of a life-cycle cost approach,it is necessary to look at some examples. Life-cycle costs(LCC) can be broken down into five elements: initial investment costs (I), salvage value (SV), maintenance and repair costs (M), replacement costs (R), and energy costs (E). Expressed as an equation:

$$LCC = I - SV + M + R + E$$

To avoid the comparison of apples to oranges, all future sums of money must be discounted to their present value using the discount factors from OMB circular 104 [Ref. 13].

1. Example One: Heat Pump Versus Oil Furnace/Air Conditioner

For the first example, the differences between a heat pump and a combination with an oil furnace and an electric air conditioner is examined.

Any commonalities that exist in the cost calculations, such as the ductwork can be ignored.

The problem assumptions are:

	Heat Pump	Oil Furnace/ Air Conditioner
initial investment	$2500	$1500
annual maintenance	100	75
replacement cost	2@ 700(note 1)	500(note 2)
electricity annually	700	400
escalation rate	5%	5%
fuel oil annually	---	800
escalation rate	---	7%
salvage value	0	0
discount rate	8%	8%
useful life	20 years	20 years

notes:

1) Calls for the replacement of the compressor twice, in the eighth and sixteenth years.

2) The air conditioner must be replaced in the tenth year.

Using the previous formula, and discounting to a present value, the life-cycle costs of each alternative can be determined, starting first with the heat pump.

<u>Heat Pump</u>

Present Value:

of Maintenance = \$100 * (PVa,8%,20 yrs.)
= \$100 * (.9818)
= \$981.81

of Replacement = $700 * [(PVf,8%, 8 yrs.) +(PVf,8%,16 yrs.)]
= $700 * [(.5403) + (.2919)]
= $700 * (.8322)
= $582.53

of Energy = $700 * (PVa,8%, 20 yrs., with 5% escalation)
= $700 * (15.076)
= $10,553.20

LCC = I - SV + M + R + E
= $2500 - 0 + $981.81 + $582.53 + $10,553.20
= $14,617.54

<u>Oil Furnace/Air Conditioner</u>

Present Value:

of Maintenance = $75 * (PVa, 8%, 20 yrs)
= $75 * (9.8181)
= $736.36

of Replacement = $500 * (PVf, 8%, 10 yrs)
= $500 * (.4632)
= $231.60

of Energy (Electricity) = $400 * (PVa,8%, 20 yrs., with 5% escalation)
= $400 * (15.076)
= $6,030.40

of Energy (Oil) = $800 * (PVa,8%, 20 yrs., with 7% escalation)
= $800 * (18.165)
= $14,532.00

LCC = I - SV + M + R + E
= $1500 - 0 + $736.36 + $231.60 + ($6,030.40) (+ $14,532.00)
= $1500 - 0 + $736.36 + $231.60 + $20,562.40
= $23,030.36

Comparing the life-cycle costs, the heat pump alternative saves $8,412.82 over its life span for an increase in the initial investment of only $1000.

2. Example Two: Combined Active Solar/Conventional Versus Conventional Only

Another illustration can be considered. This time the cost effectiveness of a solar energy system with a conventional backup system is evaluated against a conventional system alone.

The problem assumptions are:

	Combined	Conventional Only
initial investment	$10,000	$6,000
annual maintenance	200	175
replacement costs	0	3,000(note 1)
energy costs	300	1,200
escalation rate	5%	5%
salvage value	0	2,000(note 2)
discount rate	10%	10%
useful life	20 yrs.	20 yrs.

notes: 1) The conventional system must be replaced in the fifteenth year.

2) The conventional system has a salvage value in the twentieth year.

Combined Solar/Conventional

Present Value:

```
of Maintenance = $200 * (PVa, 10%, 20 yrs)
               = $200 * (8.5136)
               = $1702.71


of Replacement = 0


of Energy = $300 * (PVa, 10%, 20 yrs,
                    with 5% escalation)
          = $300 * (12.718)
          = $2815.40


of Salvage Value = 0
```

```
LCC = I - SV + M + R + E
    = $10,000 - 0 + $1702.71 + 0 + $3815.40
    = $15,518.11
```

Conventional Only

Present Value:

```
of Maintenance = $175 * (PVa, 10%, 20 yrs)
               = $175 * (8.5136)
               = $1,489.88

of Replacement = $3000 * (PVf, 10%, 15 yrs)
               = $3000 * (.2394)
               = $718.18


of Energy = $1200 * (PVa, 10%, 20 yrs,
                     with 5% escalation)
          = $1200 * (12.718)
          = $15,261.60


of Salvage Value = $2000 * (PVf, 10%, 20 yrs)
                 = $2000 * (.1486)
                 = $297.29
```

$$
\begin{aligned}
LCC &= I - SV + M + R + E \\
&= \$5{,}000 - \$297.29 + \$1{,}489.88 \\
&\quad + \$718.18 + \$15{,}261.60 \\
&= 23{,}172.37
\end{aligned}
$$

In terms of initial investment the combined solar/conventional system costs 67% more than the conventional only system

$$\left(\frac{\$10{,}000 - \$6{,}000}{\$6{,}000} = .67 \right),$$

but in terms of life-cycle costs the combined solar/conventional system costs 33% less than the conventional only system

$$\left(\frac{\$23{,}172.37 - \$15{,}518.11}{\$23{,}172.37} = .33 \right).$$

B. SUMMARY OF RESULTS

Although both of the previous examples show cases in which a higher initial investment reduced the overall life-cycle costs, increasing the initial investment does not always lower the life cycle costs. The relationship between initial investment costs and life-cycle costs is very dependent upon two factors:

1. The rate of inflation is the most important factor. If inflation causes the discount factor to be such that the present value of future savings are negligible, then increased

investment in the initial construction is not justified.

2. The time table for payments and savings is important, but in a secondary nature. If the savings occur only at the end of the life-cycle, discounting will greatly reduce their benefits. The cases occur when the savings are immediate or when they are spread evenly over the life of the project.

Therefore, all alternatives should be examined on their individual merits with respect to life cycle costs. Table 5.1 provides a side by side comparison of initial investment costs and life-cycle costs for each alternative of both examples.

Reviewing the results of the examples, in the case of example one the increased initial investment provides a return in excess of 840%. In comparing the alternatives of example two, the extra investment provides a 191% return. Table 5.2 shows the return on the increased investment for each example.

TABLE 5.1 SUMMARY TABLE FOR EXAMPLE ALTERNATIVES

	INITIAL INVESTMENT	LIFE-CYCLE COSTS	SAVINGS POTENTIAL
HEAT PUMP VERSUS	$2,500	$14,518	$8,412
OIL FURNACE AIR COND.	$1,500	$23,030	
COMBINED ACTIVE SOLAR & CONVENT. VERSUS	$10,000	$15,518	$7,654
CONVENTIONAL ONLY	$6,000	$23,172	

TABLE 5.2 RETURN ON INVESTMENT

EXAMPLE	INCREASE IN INITIAL INVESTMENT	REDUCTION IN LIFE-CYCLE COSTS	RETURN ON INVESTMENT
ONE	$1,000	$8,412.82	841.3%
TWO	$4,000	$7,654.26	191.4%

VI. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

Program guidance from Congress emphasizes the relevance and importance of life-cycle costs, and the same documentation also requires life-cycle costs be part of the program analysis [Ref. 24]. From a minor military construction project to major weapon system acquisition, operating costs play a key role in the decision process. To quote a 1969 Rand Corporation Memorandum:

> ... operating costs are far more important in the lifetime total cost computation than their annual figure might suggest. In fact, since the life of a modern weapon system may run ten years (or longer), the investment needed to establish a new system may be dwarfed by the costs required to operate and to maintain it. [Ref. 18]

If operating costs are so influential on the total cost of a project, why does an 801 program analysis exclude the energy consumption costs? Upon initial examination the energy consumption costs might be ignored, just as the Army ignored them in the first 801 program analysis because it can be assumed that the energy consumption costs are equal for each alternative. That assumption may not be valid, because the structures for each alternative has a different design.

Chapter V provides examples that illustrate a higher initial construction cost can provide a lower life-cycle cost. If windows and doors do not receive proper maintenance, they can degrade the energy efficiency of the housing units. Currently, air infiltration accounts for approximately one-third of the energy loss in Navy housing. [Ref. 10]

Energy consumption costs are very important in terms of life-cycle costs, and as long as they remain a separate issue, the true costs of an 801 project will remain hidden. The inclusion of energy consumption costs would more accurately reflect the total cost of the 801 program, and then the program could be evaluated with respect to the method of direct payment to service members of BAQ and VHA.

The inclusion of utility consumption costs in the 801 program contract will provide a real incentive for the contractor to ensure the energy efficiency of the housing project. Inclusion of energy consumption costs in the lease contract will require some form of reimbursement to the contractor. That reimbursement could take many forms. One method might be a payment for a negotiated standard consumption level at a fluxuating utility rate. Another method might revolve around a percentage share for the contractor for any savings he could provide to the government below an established baseline.

Guidance from OMB specifically states that when an agency submits a program for congressional review, it must contain all life-cycle cost. The omission of energy consumption costs could lead to a decision that is prejudicial either for or against the 801 program.

B. RECOMMENDATIONS

What incentives are given to a contractor to ensure an energy efficient project? After examining the point system, it is known that a bidder could conceivably lose most of the 100 points for energy conservation and still win the design award. In reality, it can be seen that the current approach, in which the lowest bid wins, only provides incentive for the contractor to cut construction costs wherever possible. A lower initial cost increases the probability of higher energy costs and higher life-cycle costs.

For terms of illustration, an example follows of the point system with respect to energy conservation, for 300 housing units with annual energy consumption rates of $1000 without conservation and $500 with maximum conservation.

	Minimum Standard	Maximum Efficiency
Quality Points	1150	1200
Initial Cost	$10,000,000	$11,000,000
Cost/point	$8,696/pt	$9,167/pt
Annual Energy Cost	$300,000	$150,000
Present Value of Energy Cost at an 8% discount rate	$2,950,000	$1,470,000
Total Cost	$12,950,000	$12,470,000
Savings	----	$490,000

The program decision would be based on the lowest cost per quality point. In this case the 50 point difference can be attributed to the quality points for energy efficiency as outlined in Chapter III, Section B. Cost divided by quality point would be equal for each alternative if initial costs differed by only 4.35% for the maximum alternative over the minimum.

The idea of awarding a contract based on lowest life-cycle costs is alien to the present form of budgeting. Annual budgets and election years place heavy emphasis on current spending with little or no concern for next year's budget.

It is recommended that the decision criteria for the 801 program be based on total life-cycle costs,

and that those costs should be all inclusive so as not to preclude innovation on the part of the contractor. Using the same approach used in major weapon system acquisition could save the government money.

C. AREAS FOR FURTHER RESEARCH

1. Financial Management Areas

During the development of this thesis, certain aspects of the 801 and 802 family housing program raised questions that remain unanswered. Most of these areas could provide excellent thesis topics.

Some topics for future research include:

a. How do you determine the value and inherent risk of an 801 program lease? Given that:

   1) The lease is subject to annual appropriations, (i.e. Congress could default.)

   2) There is no defined secondary market, thus making liquidity impossible to access.

   3) The lease does share similarities with corporate bonds.

b. What is the impact of OMB's definition of the value of capital?

c. The 801 program alternative decision process routinely performs a sensitivity analysis of key cost parameters, but the discounting rate undergoes no such analysis. At what level of discounting does the decision change?

d. What are the impacts of sunk costs, such as government owned land, on the decision process?

e. Could pressure from private industry force the government to purchase the land required for future 801 and 802 family housing projects?

f. What effect will the new federal tax bill and its stance on long term capital gains have on potential capital investors in family housing construction?

g. What course of action should the service take when it receives no bids on an 801 project?

2. <u>Energy Conservation Area</u>

This thesis does not deal with the technical or engineering aspects of energy conservation. Nevertheless, one technical question did arise:

What is the long term effect of the level of provided maintenance on the energy efficiency of a structure?

APPENDIX A -THE 801 FAMILY HOUSING PROGRAM
[Source Ref. 19]

PUBLIC LAW 98-115--OCT. 11, 1983
TITLE VIII--GENERAL PROVISIONS
MILITARY FAMILY HOUSING LEASING PROGRAM

Sec. 801. Section 2828 of Title 10, United States Code, is amended by adding at the end thereof the following subsection:

"(g)(1) Notwithstanding any other provision of law, the Secretary of a military department may enter into a contract for the lease of family housing units to be constructed on or near a military installation within the United States under the Secretary's jurisdiction at which there is a validated deficit in family housing. Housing units leased under this subsection shall be assigned, without rental charge, as family housing to members of the armed forces who are eligible for assignment to military family housing. A contract under this section shall include a provision that the obligation of the United States to make payments under the contract in any fiscal year is subject to the availability of appropriations for that purpose.

"(2) Each contract under paragraph (1) shall be awarded through the use of publicly advertised, competitively bid or competitively negotiated contracting procedures. Such a contract may provide

for the contractor of the housing facilities to operate and maintain such housing facilities during the term of the lease.

"(3) Each contract under this subsection shall require that housing units constructed pursuant to the contract shall be constructed to Department of Defense specifications.

"(4) A contract under this subsection may be for any period not in excess of 20 years (excluding the period required to construction of the housing facilities).

"(5) A contract under this subsection shall provide that, upon the termination of the lease period, the United States shall have the right of first refusal to acquire all right, title, and interest to the housing facilities constructed and leased under the contract.

"(6) A contract may not be entered into for the lease of housing facilities under this subsection until--

"(A) the Secretary of Defense submits to the appropriate committees of Congress, in writing, an economic analysis (based upon accepted life cycle costing procedures) which demonstrates that the proposed contract is cost effective when compared

with alternative means of furnishing the same housing facilities; and

"(B) a period of 21 calendar days has expired following the date on which the economic analysis is received by those committees.

"(7) This subsection may be implemented only by a pilot program. In carrying out such pilot program--

"(A) the Secretary of each military department may not enter into more than two contracts under this subsection; and

"(B) any such contract may not be for more than 300 family housing units.

"(8) A contract may not be entered into under this subsection after October 1, 1985."

APPENDIX B - THE 802 FAMILY HOUSING PROGRAM
[Source Ref. 20]

PUBLIC LAW 98-115--OCT. 11, 1983
TITLE VIII----GENERAL PROVISIONS
MILITARY FAMILY HOUSING LEASING PROGRAM

Sec. 802. (a) The Secretary of a military department, under uniform regulations prescribed by the Secretary of Defense, may enter into an agreement to assure the occupancy of rental housing to be constructed by a private developer or by a State or local housing authority on private land, on land owned by a State or local government, or on land owned by the United States, if the housing is to be located on or near a new military installation or an existing military installation that has a shortage of housing to meet the requirements of eligible members of the Armed Forces (with or without accompanying dependents). An agreement under this section shall include a provision that the obligation of the United States to make payments under the agreement in any fiscal year is subject to the availability of appropriations for that purpose.

(b) An agreement under subsection (a)--

(1) may not assure the occupancy of more than 97 percent of the units constructed under the agreement;

(2) shall establish initial rental rates that are not more than rates for comparable rental dwelling units in the same general market area and may include an escalation clause for operation and maintenance costs which shall (if included) be effective for the term of agreement;

(3) may not apply to existing housing;

(4) shall require that the housing units be constructed to Department of Defense specifications;

(5) may not be for a term in excess of 15 years;

(6) may not renewed;

(7) may not assure more than an amount equivalent to the shelter rent of the housing units, determined on the basis of amortizing initial construction costs;

(8) may only be entered into to the extent that there is a validated deficit in military family housing;

(9) may only be entered into if existing military-controlled housing at all installations in the commuting area (except for a new installation or an installation for which there is projected a significant increase in the number of families due to an increase in the number of authorized personnel) has exceeded 97 percent use

for a period of not less than 18 consecutive months immediately preceding the date on which the agreement is entered into, excluding units temporarily inactivated for major repair or improvements;

(10) shall provide for priority of occupancy for military families, and

(11) shall include a clause rendering the agreement null and void if, in the opinion of the Secretary of the military department concerned, the owner of the housing fails to maintain a satisfactory level of operation and maintenance.

(c) An agreement under subsection (a) shall be made through the use of publicly advertised, competitively bid or competitively negotiated procedures.

(d) An agreement may not be entered into under subsection (a) until--

(1) the Secretary of Defense submits to the appropriate committees of Congress, in writing, an economic analysis (based upon accepted life cycle costing procedures) which demonstrates that the proposed agreement is cost effective when compared with alternative means of furnishing the same housing facilities; and

(2) a period of 21 calendar days has expired following the date on which the economic analysis is received by those committees.

(e) The Secretary concerned may require that disputes arising under an agreement entered into under subsection (a) be decided in accordance with the procedures provided for by the Contract Disputes Act of 1978 (41 U.S.C. 6012 et seq.).

(f) This section may be implemented only by a pilot program. In carrying out such pilot program--

(1) the Secretary of each military department may not enter into more than two agreements under this section; and

(2) the Secretary of a military department may not enter into such an agreement for more than 300 family housing units at one location.

(g) An agreement may not be entered into under this section after September 30, 1985.

APPENDIX C - QUALITY POINT SYSTEM FOR TECHNICAL EVALUATION OF SECTION 801 PROGRAM ALTERNATIVES
[Source Ref. 21]

A. TECHNICAL EVALUATION FACTORS:

1. Total Points — MAXIMUM 1,200 points

a. Site/Unit Design and Eng. — MAXIMUM 1,000 points

b. Maintenance — MAXIMUM 200 points

2. Site Design — MAXIMUM 300 points

This area of evaluation includes overall planning, layout, design and development of the housing site(s). It embraces considerations of community appearance, compatibility of grounds and buildings, solar orientation, functionality and livability. Generally, excluded are considerations of the relative quality of materials, with the exception of landscaping, which includes numbers, types and quality of planting other than ground cover.

a. Site Utilization and Development: (50 points)

Maximum project density in living units per gross acre is pre-established by the Project Scope and Composition (number of units and number of bedrooms) in relation to total acreage prescribed for development. The extent to which

proposals make efficient use of the site, shall be considered under this category.

1) Street and Block Pattern.
2) Structure Grouping and Variation.
3) Structure/Solar Orientation.
4) Buffering, Privacy,and Open Space.

b. Site Location: (50 points)

Assessment of proposed site in terms of its advantages with particular concern for avoidance of conditions which would reduce the quality of life for the military families and complicate management objectives.

1) Site Configuration

Objectives of management and maintenance place greater desirability on project siting on one site rather than several. If multiple sites cannot be avoided, what proximity and accessibility is afforded.

2) Site Accessibility.

Commuting distance to work place. Proximity to public transportation. Relationship to convenience shopping, recreation, and schools.

3) Environmental Quality.

Desirability of neighborhood. Security requirements. Safety of children at unsupervised play.

Absence of noxious odors, visual clutter, industrial pollutants, and other inappropriate land use.

4) Site Integration

Integration of relationships between the site and surrounding region, with specific concern for climate, topography, architecture, and historic significance.

c. Street System: (35 points)

1) Vehicular Circulation
   - ACCESS AND TRAFFIC CONFLICTS
   - SERVICE VEHICULAR ACCESS
2) Street Design

d. Parking: (30 points)

1) Quantity and Proximity to Dwelling Units
2) Driveway/Parking Area Layout

e. Utility Systems: (25 points)

Evaluate system design and layout including preservation of natural features. Quality of materials and equipment are evaluated under site engineering.

1) Electrical Distribution
2) Water Distribution
3) Sanitary Sewer System
4) Storm Drainage
5) Gas Distribution

f. Site Grading (30 points)

This factor considers the appropriateness of proposed grading plans including, but not limited to, efficiency of the surface

drainage, cut and fill, engineering economies, slopes and gradients, and soil stabilization, if required. Considerations of aesthetic qualities of the grading plan(s) are addressed under Landscaping (Environmental preservation considerations are evaluated under Item k).

1) Grading Design

g. Pedestrian Circulation: (20 points)

This factor concerns the way in which the walkway system performs the function of transporting pedestrians from one essential location to another.

1) To Building, Parking and Refuse Disposal
2) To Recreation Areas, School Bus Stops, and Community Building

h. Landscaping, Cover, Irrigation and Soil Treatment: (25 points)

1) Plant Materials
2) Topsoil and/or Treatment of Soil
3) Quality of Grass and Ground Cover
4) Provision for Watering
5) Landscape Grading

i. Recreation Areas: (15 points)

1) Major Recreation Areas

- An open space with a minimum dimension of 50 feet may be considered an area for active recreation. A good plan should provide one such area for every 50 to 60 dwelling units. The occasional grouping of two or more such areas to provide a large

open space usable for sandlot football, softball, etc., is desirable.

2) Playgrounds and Tot Lots

j. Recreational Vehicle Storage (5 points)

k. Environmental Considerations (15 points)

1) Preservation of Natural Features:

3. Site Engineering: MAXIMUM 100 points

This area is limited to considerations of quality of materials and engineering aspects of operation and maintenance, unless otherwise specifically indicated. Utility systems are to be evaluated up to the five foot line of the housing units. Layout and design consideration for utility systems are evaluated under Site Design.

a. Utility Systems (70 points)

1) Electrical Distribution Systems
2) Water Distribution System
3) Sanitary Sewer System
4) Gas Distribution System (If provided by Contractor)
5) Storm Drainage System
6) Exterior and Street Lighting

b. Street Construction: (10 points)

c. Parking/Driveways/Walkways and Pathways (10 points)

Base and wearing surface quality.

d. Recreational Equipment (5 points)

Playground and/or tot lot equipment provided by proposer. Consider quality, quantity and type.

e. Environmental (5 points)

Does site provide for proper control of rain runoff.

4. Dwelling Unit Design: MAXIMUM 500 points

The factors and elements considered herein deal with the planning and design of the dwelling units, as opposed to durability of the materials and engineering considerations. Considerations are given to (1) the interaction of the individual housing unit to people, (2) the degree to which the unit blends with those outdoor features of living normally associated with the family, (3) the overall aesthetics of the housing unit, and (4) the amenities associated with livability. These latter include such items as separation of activities, convenience, orderliness, logistics, leisure, bathing, food handling and sleeping.

a. Dwelling Unit Type: (15 points)

Use the following equation:

$$\frac{\text{NUMBER UNITS EACH TYPE} \times \text{VALUE FACTOR EACH TYPE}}{\text{TOTAL UNITS}} = \text{POINTS}$$

VALUE FACTORS:

	NUMBER UNITS/BUILDING				
	1	2	3-4	5-8	9-12
2BR	15	15	15	13	10

b. Exterior Appearance: (35 points)

This factor considers the overall aesthetics of the building exteriors including: variety of facades, visual effect of garages and/or carports, fenestration, and proportion.

c. Outdoor/Indoor Integration: (30 points)

1) Layout of facilities within the unit which enhance indoor/outdoor living in balanced with climate, (e.g., patios, screen porches, vistas and yard areas.)

2) Screened and roofed enclosures (consider use of materials and climatic desirability).

3) Privacy Fencing

d. Storage (25 points)

Consideration must be given to size, location and utility of all storage areas.

1) Exterior Bulk Storage
2) Interior Bulk Storage
3) Closets (Linen, Coat, Clothing)

e. Garages/Carports: (10 points)

Aesthetics are considered under b. If provided, give consideration to attachment,

proximity, and/or covered walkways to living units as well as climatic conditions.

f. Functional Arrangement: (35 points)

Does the floor plan of the unit provide desirable relationships between living, food handling, sleeping and bathing areas? Does the relationship of the areas conflict with or enhance each other? Are the logistics of home operation considered (e.g., furnishability, expendable supply and disposal.) In all of the above, consideration must be given to the family size which dictates unit size.

g. Circulation: (15 points)

Accessibility without disturbing other activities. Ease of furniture movement (particularly at stairs).

h. Apportioning of Space: (20 points)

To maximize livability and efficiency of household functions.

i. Living: (35 points)

Considerations of interior design, which enhance the individual and family group aspects of recreation, leisure and entertainment. Consider window and door placements, furnishability, traffic patterns and clearances under use conditions.

Family Room/Secondary Dining - add points when provided.

j. Sleeping (30 points)

1) Bedroom Size (Add points for area and/or dimensions in excess of specified minimum).
2) Furnishability.
3) Ceiling Light Fixture.
4) Privacy (Visual, Acoustic).

k. Bathing: (15 points)

Number and size (add points for that in addition to minimum specified.)
Layout and privacy.
Accessibility (guest, master bedroom)

l. Food Handling: (30 points)

It can be said that nearly all of the activities of the family housing group are heavily affe4cted by the design quality of the food handling area. Considerable initiative and innovative approaches to the design of area can be achieved to enhance this major logistics and control area. Keep in mind that excessive floor area can mitigate against efficiency.

1) Efficiency
2) Storage
3) Privacy (Visual) window/door size and location.
4) Eating/service counter.

m. Utility and Work Areas: (15 points)

Address provision for occupant-owned or Government-furnished washers and dryers in an area of the unit which provides for efficient product

circulation and yet does not infringe on other functions.

Size and layout (Add points for areas suitable for ironing and/or light hobby work).

n. Energy Consumption Analysis: (100 points)

UNIT CONSERVATION LEVELS

1) Energy performance limitation met by proposal:

BTU/HR/SR/DD	10	9	8	7	6	5
Points/	5	15	25	35	45	55

2) Active solar domestic hot water contribution:

% contribution	< 45	45 to 55	> 55
Points	0	5	15

3) Passive solar space heating:

% contribution	< 20	20 to 40	> 40
Points	0	15	30

EXAMPLE CALCULATION:

UNIT TYPE 2 Bedroom

GROSS FLOOR AREA 1207 SF

NUMBER STORIES/UNIT 1 in 4- plex

GLASS AREA/UNIT: = sf x .65("U") =58.5BTU

EXT.WALL AREA/UNIT: 860 - 90= 750SF x.66("U") =49.5BTU

ROOF AREA/UNIT: 1207 / 2 =604 sf x.033 ("U") =19.9BTU

TOTAL EFFECTIVE BTUs 127.9

$$\frac{\text{BTU} \quad \text{X} \quad \text{HRS/DAY} \quad \text{X} \quad \text{NO. UNITS}}{\text{UNIT AREA}} = \frac{\text{BTU/SF}}{\text{DD-ANNUALLY}}$$

$$\frac{\text{127.9 BTU--X--24 HR--X--300 UNIT}}{\text{UNIT AREA}} = 24.54$$

PROPOSER'S CALCULATION:

UNIT TYPE ______________________________

GROSS FLOOR AREA______________________

NUMBER STORIES/UNIT___________________

GLASS AREA/UNIT:______________=_____SF X__("U")=__BTU

EXTERIOR WALL AREA/UNIT:__-____=____SF X__("U")=__BTU

ROOF AREA/UNIT_______________=______SF X__("U")=__BTU

TOTAL EFFECTIVE BTUs _____BTU

$\frac{\_\_\_\ \text{X}\ \ \text{HRS/DAY}\ \ \text{X}\ \ \text{NO. UNITS}}{\text{UNIT AREA}}$ = BTU/SF/DD-ANNUALLY

$\frac{\_\_\_\ \text{X}\ \ \_\_\_\ \text{HR}\ \ \text{X}\ \ \_\_\_\ \text{1 UNIT}}{\text{SF}}$ = _______

o. Windows, Doors, and Hardware: (20 points)

Evaluate suitability and aesthetic qualities of proposed windows, doors, and hardware.

1) Windows and Window Coverings
2) Doors
3) Hardware

p. Cabinets and Countertops (10 points)

Evaluate suitability and aesthetic qualities of kitchen and bathroom cabinets and countertops.

q. Interior Plumbing(Includes solar): (10 points)

Evaluate system for functional arrangement, layout, design and economies. Quality of material is evaluated under dwelling unit engineering and specifications.

r. Interior Electrical System . (5 points)

Evaluate system for functional arrangement, layout, design and economies.

s. Heating, Ventilating and Air Conditioning:(Includes Solar) (10 points)

Evaluate system design under this item.

1) System Layout
2) Equipment Placement

t. Finishes: (25 points)

Evaluation shall consider the maintainability, durability, and quality of the finishes, materials and features incorporated in the items and systems offered, with particular emphasis placed on daily household maintainability.

1) Flooring
2) Exterior Walls
3) Interior Walls

u. Other Miscellaneous Features: (10 points)

5. Dwelling Unit Eng. and Specifications:

MAXIMUM 100 points

Dwelling Unit Engineering and Specifications will evaluate the quality of the proposed construction materials and equipment and the technical adequacy of the engineering features and product specifications including energy conservation characteristics.

a. Foundation System: (10 points)

Evaluation shall consider the type foundation system provided, quality of materials and construction details.

1) Slab-on-Grade
2) Perimeter Wall(Crawl Space)
3) Other Foundation Systems

b. Flooring System: (10 points)

c. Exterior, Interior and Party Walls and Ceilings: (10 points)

1) Construction
2) Insulation(Thermal and Sound)
3) Sheathing

d. Roof System: (5 points)

Evaluation of the roof system shall address structural and quality factors, including maintenance considerations. The roof system consists of the framing system (including eaves), sheathing, roofing, flashing, and gutters and downspouts.

1) Framing
2) Roofing and Sheathing
3) Gutters/Downspouts/Flashing

e. Windows and Window Coverings: (5 points)

f. Doors(Including Hardware): (5 points)

Doors and hardware shall be evaluated on basis of quality of materials and maintainability.

1) Exterior Doors
2) Interior Doors
3) Hardware

g. Cabinets and Counter Tops: (5 points)

Evaluation will consider the features, materials and equipment, being provided for cabinets in kitchens and bathrooms.

h. Plumbing System: (10 points)

Evaluate quality of materials and maintainability.

i. Interior Electrical System and Television System: (5 points)

Evaluate quality of materials and maintainability.

1) Wiring

2) Fixtures

j. Heating, Ventilation, Air Conditioning and Solar: (10 points)

Evaluate quality of equipment and maintainability.

k. Maintainability: (15 points)

Consider maintenance-reducing qualities of proposed materials, finishes and systems. Use of commonly available standardized materials and techniques to promote economical repair of replacement is highly desirable.

1) Exterior Walls and Trim
2) Roofs
3) Doors, Windows and Hardware
4) Interior Finishes and Trim
5) Cabinets
6) Bathrooms
7) Utility Systems Including Heating, Ventilating, and Air Conditioning

l. Appliances: (10 points)

EER of each major appliance.

6. Maintenance, Repair, and Operational Services: MAXIMUM 200 points

The factors and elements considered herein deal with the operation and maintenance of the Housing Site subsequent to the initial acceptance by the Government. Overall, the technical proposal is evaluated for realism and validity. Considerations are given to the background and experience of the proposer, especially in areas related to the functions required in Section VI of the Lease Agreement and specific plans for compliance with this Section to include organizational and supervisory relationships, quality control, and work procedures to be followed.

a. Organizational and Administrative Capabilities: (50 points)

1) Past experience in the operation and maintenance of residential and commercial property of the same or similar scope and size as contained herein. Indicate if previous phase-ins were from an existing contractor operation or from Government operations, and whether or not it

was under the A-76 Commercial Activities Program. Identify contracts, dollar value, client, locations, etc. Indicate how that experience is relevant to the requirements of this RFP List experience of proposed subcontractors separately. Specific experience including, but not necessarily limited to the following:

(25 points)

- Dwelling units
- Support facilities
- Grounds
- Roads and Streets
- Refuse collection
- Pest control

2) Proposer organization and staffing.

Consideration will include, but not be limited to the following:

(25 points)

- Organizational structure, (Headquarters through on-site) which will be involved in the execution and administration of Section VI.

- Number of full-time people located on-site.

- Qualifications and skills of key personnel located on-site or off- site.

- Titles and duties of each individual.

- Lines of authority and supervision.

- Rationale for on-site manning levels.
- Work flow procedure.

b. <u>Plans and Methods for Compliance with Section VI:</u> (150 points)

1) Number and locations of Developer's administrative facilities.
   - Designated use of facilities.
   - Location in relationship to other housing sites, if more than one.

2) Specific execution plan to accomplish the following: (Identify whether item will be performed by the Developer, subcontracted, provided by local government or authority,etc.)
   - Maintenance of housing units, administrative spaces, and other support facilities.
   - Grounds maintenance
   - Roads and streets
   - Pest control
   - Refuse collection
   - Police and fire protection

- Provision of utilities to Housing Site
- Identify each supplier
- Identify rate schedule which will be used to bill the Government (e.g., residential, industrial)
- Type of metering (e.g., individual, master)
- How will Government be billed for utilities.
- Provide most current rate for schedule identified above which Government would pay
- Provisions for payment for cost of utilities provided to Developer's administrative space (e.g. separately metered, direct payment to supplier, reimbursement to Government)

3) Developer Quality Control Program
- Quality control inspection system covering all aspects of the maintenance annex.
- Specific qualifications and extent of authority of individual(s) tasked to perform quality control.

-Method for identifying deficiencies in quality of services performed and corrective action to be taken before level of performance becomes unsatisfactory.

Methods for correction of deficiencies for items of work which are time-sensitive, (e.g., change of occupancy work, E/S calls.)

-Filing system to record quality control inspections, inspection results, and method of correction.

4) Methods for accomplishment of change of occupancy work.

- Coordination and scheduling of trades.
- Plan for attaining average three-day downtime.
- Coordination with Government.
- Who will participate in pre-termination and acceptance inspections.

5) Plans for coordination and scheduling of work other than change of occupancy (e.g., E/S calls,

preventive maintenance inspections, pest control inspections.)

- Notification of tenants.
- Coordination with Government.
- Situations where tenants are not home
- Provisions for receipt and response to E/S calls (e.g., number of lines, manning, receipt during off-hours).
- Procedures for exchange of written correspondence (e.g., pick-ups and drop- offs, signature authorities).

6) Plans for repair or replacement of major components, (e.g., roofs, HVAC equipment, appliances.)

- Expected schedule over 20-year period.
- Who will accomplish? Sub-contractor, Developer personnel?
- Expected impact on tenants, (e.g., relocation, inconvenience.)
- Methods for accomplishment, (e.g., during change of occupancy, vacating of

units, while unit is occupied, etc.)

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